# A FINAL BIRD WASHER
## Design, Specifications and Evaluation

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# A FINAL BIRD WASHER
## Design, Specifications, and Evaluation

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## SUMMARY

A final bird washer designed and developed for use in poultry processing plants, and constructed of flat-spray nozzles and other readily available components, cleaned broiler carcasses satisfactorily both visibly and bacteriologically with less water than is now used in commercial washers.

## INTRODUCTION

In commercial poultry processing plants processing debris is removed from freshly slaughtered and eviscerated chicken carcasses by a thorough spray washing before chilling as specified by "Regulations governing the inspection of poultry and poultry products," 7CFR-Part 81 (1968). The regulations specify only use of a system of sprays providing an abundant supply of fresh clean water, but do not specify design characteristics of the washer, minimum or maximum water flow rates, or water pressures. The effectiveness of a washer is judged by an inspector's visual assessment of carcasses on the processing line.

The mounting costs of water and sewage treatment, the scarcity of water in some areas, and recent pollution-control legislation have generated an awareness and a concern for effective water utilization.

A preliminary survey of poultry processing operations showed widely varying water use rates at the final bird washer. According to one recent report[2] the final washer flow rate in one plant was about two-thirds gallon of fresh water per bird (about 53 gallons per minute per washer). Most plants use at least two such washers, resulting in washer water usage of more than 100 gallons per minute. At 25 cents per 1,000 gallons, 100 gallons per minute will cost approximately $2,880 annually if the plant operates for one 8-hour shift per day. Total water consumption in many processing plants may be more than 10 times this much.

Although most commercial final washers rinse broiler carcasses satisfactorily, they are not designed for effective water utilization. They may be equipped with various types of spray nozzles, or may simply be pipe manifolds with drilled holes instead of nozzles. Nozzles are often poorly arranged in the washer assembly, and do not direct all of the water onto the carcasses. Moisture uptake ranges from 1½ to 3 percent of carcass weight in commercial washers, depending on the water flow rate, pressure, etc. One report[3] indicated that effective bacteria removal by commercial bird washers in ten plants varied from 36 to 96 percent. This variation is understandable in light of the great variation in water application in procession plants. Some use too little water and some use much more than necessary for effective washing.

This study aimed to develop a design and specifications for a final bird washer that would minimize the amount of water required to clean carcasses effectively. Specific objectives were to determine the cleaning effectiveness and water use rates of washer components under various conditions; to design, construct and test an experimental washer for cleaning broiler carcasses effectively with less water than conventional washers; and to furnish guidelines for improving old washers or building new units.

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[2] Ward, R. C., and Crosswhite, W. M. What to do now about reducing water, waste. Broiler Ind. 34(9) : 68-90. 1971.

[3] May, K. N. Skin contamination of broilers during commercial evisceration. Poultry Science 40:531-536. 1961.

# EQUIPMENT DEVELOPMENT

To facilitate the evaluation of washer components, an experimental portable washer frame and single conveyor line were constructed (fig. 1), complete with an overhead monorail conveyor with shackles mounted on 6-inch centers. The conveyor was set to handle about 40 birds per minute, a rate typical of commercial evisceration lines. A flowmeter, a pressure regulating valve, and a pressure gage were installed in-line to control and monitor water pressure and flow rate.

## Nozzle Selection

The first step in developing the washer was to evaluate the effectiveness of various commercially available spray nozzles. Preliminary evaluations were made by washing carcasses with various nozzles, including one cone spray pattern and two flat spray patterns, at water pressures varying from very low to very high. Carcasses were visually inspected for cleanliness; water soluble dyes were also used on the carcasses to evaluate nozzle effectiveness and placement. After extensive tests in the laboratory and in a commercial poultry processing plant, one flat-spray-pattern nozzle was found to give the best performance (fig. 2).

This nozzle has a round orifice with a tapered approach that minimizes clogging and a smoothly machined concave deflector that gives a sharp "knife-blade" flat spray pattern. It is manufactured by Spraying Systems Company; the two sizes in figure 2 are numbers 1/4 P5010 and 3/8 P5025, respectively. The 5/64-inch orifice nozzle is rated at 0.71 gal/min at 20 lb/in$^2$, and the 1/8-inch orifice at 1.8 gal/min at 20 lb/in$^2$.

## Nozzle and Manifold Assembly

The complete nozzle assembly included a nozzle and two adjustable joints (fig. 3). The brass

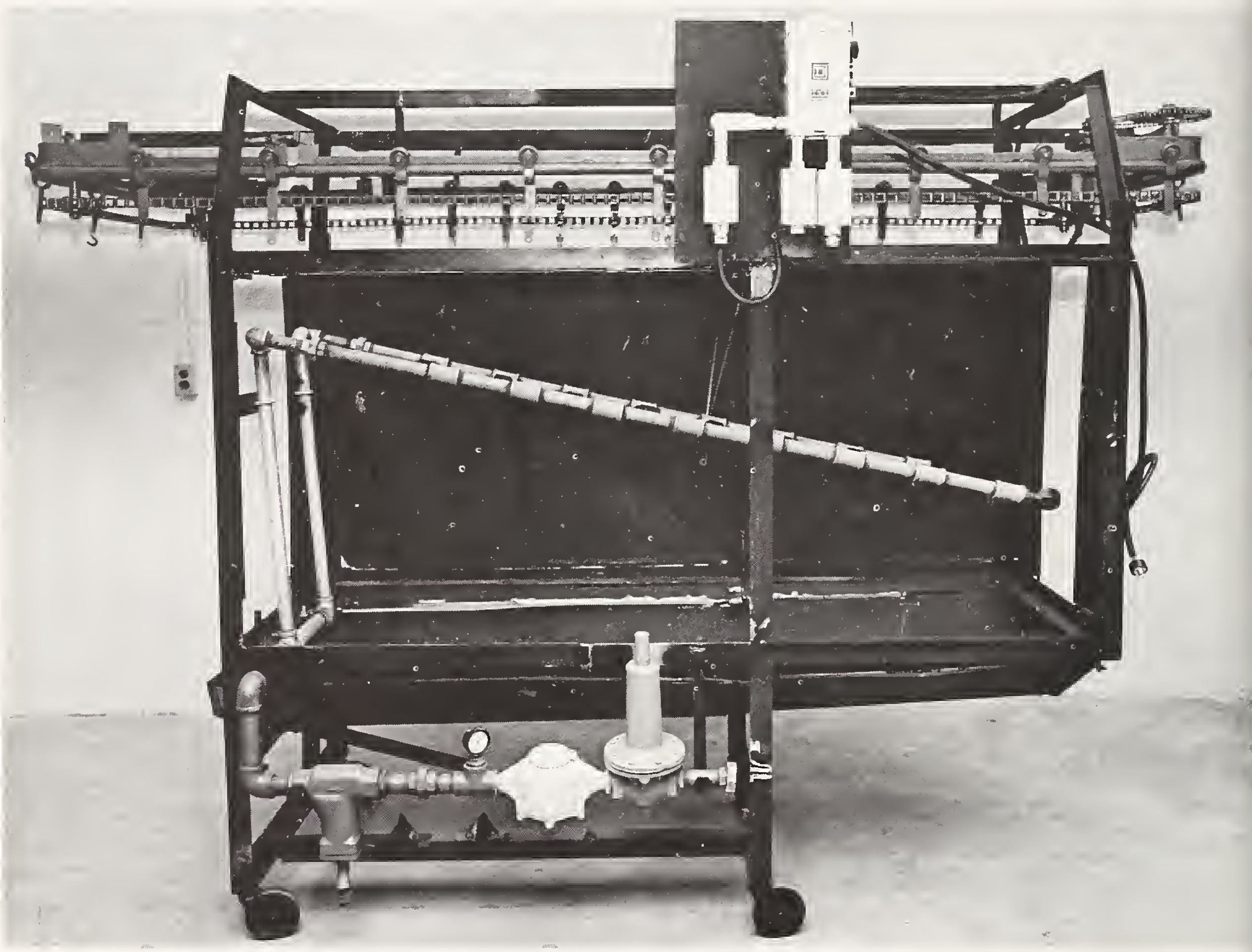

FIGURE 1.—Experimental portable washer frame and single conveyor line assembly.

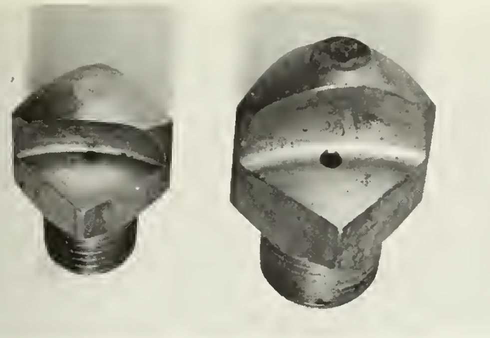

FIGURE 2.—Flat spray nozzle found to be most effective for use in washers (5/64-inch orifice (left) and 1/8-inch orifice (right)).

adjustable joints permitted wide radial adjustment of the nozzle spray. For each side of a line of chickens, eight nozzle assemblies were mounted to a manifold by 6-inch long, 1-inch nipples (fig. 4). The manifolds were mounted parallel to the conveyor lines, and sloping downward approximately twelve degrees from the horizontal to provide complete coverage of the carcass by the spray (fig. 5). The first nozzles were directed so that they washed the bird hocks and each succeeding nozzle was adjusted to wash a progressively lower portion of the carcass.

All of the nozzles were adjusted so that the flat spray pattern was in a vertical plane, at an angle of about 30 degrees from a line perpendicular to the manifold as shown in figure 4. However, spray angle is a final adjustment that must be made for each individual washer by hanging birds by the hocks on the shackles and adjusting the nozzles and joints so that every part of the carcass is struck by a spray. Therefore, the spray angle may vary from 20 to 40 degrees and be different for each nozzle.

FIGURE 3.—Nozzle and adjustable joints mounted in a ½- by 1-inch tee.

# EQUIPMENT EVALUATION

After extensive testing of the experimental washer in the laboratory, the washer manifolds and nozzle assemblies were installed inside the tunnel of an existing commercial processing plant washer (fig. 6). The unit remained in the plant for about 3 months, providing an opportunity to verify laboratory findings for the experimental unit, and also allowing visual comparison with the commercial washer.

## Water Consumption and Washer Effectiveness

Water pressure was varied from 5 to 30 lb/in$^2$ for trials with the two experimental nozzles, with 5/64- and 1/8-inch orifices. Neither nozzle was effective below 10 lb/in$^2$, and neither cleaned the carcasses adequately even at this pressure. The two nozzles were about equally effective in cleaning the carcasses at 20 lb/in$^2$, but the smaller nozzle used only 0.26 gallon of water per bird, while the large nozzle used about 2½ times this amount (0.64 gal.). Increasing the pressure above 20 lb/in$^2$ did not noticeably increase the washer effectiveness, but did start to produce fogging. The commercial washers in this and other processing plants observed were using from ¾ to 1 gallon of water per bird. Excess water usage resulted primarily from use of inefficient nozzles, poor nozzle placement, and excessive water pressure.

## Moisture Gain

Moisture uptake and retention by carcasses is not an important factor in present day bird washers since moisture gain is not measured until the end of the in-line slush-ice chiller. However, the moisture gained by 50 chickens routed through the experimental washer was compared to that of 50 that were routed through a commercial washer. Birds were removed from the eviscerating line immediately before the final washer and weighed to the nearest gram. They were tagged, hung back on the evisceration line and allowed to pass through the washer, after which they were removed from the line, hung on

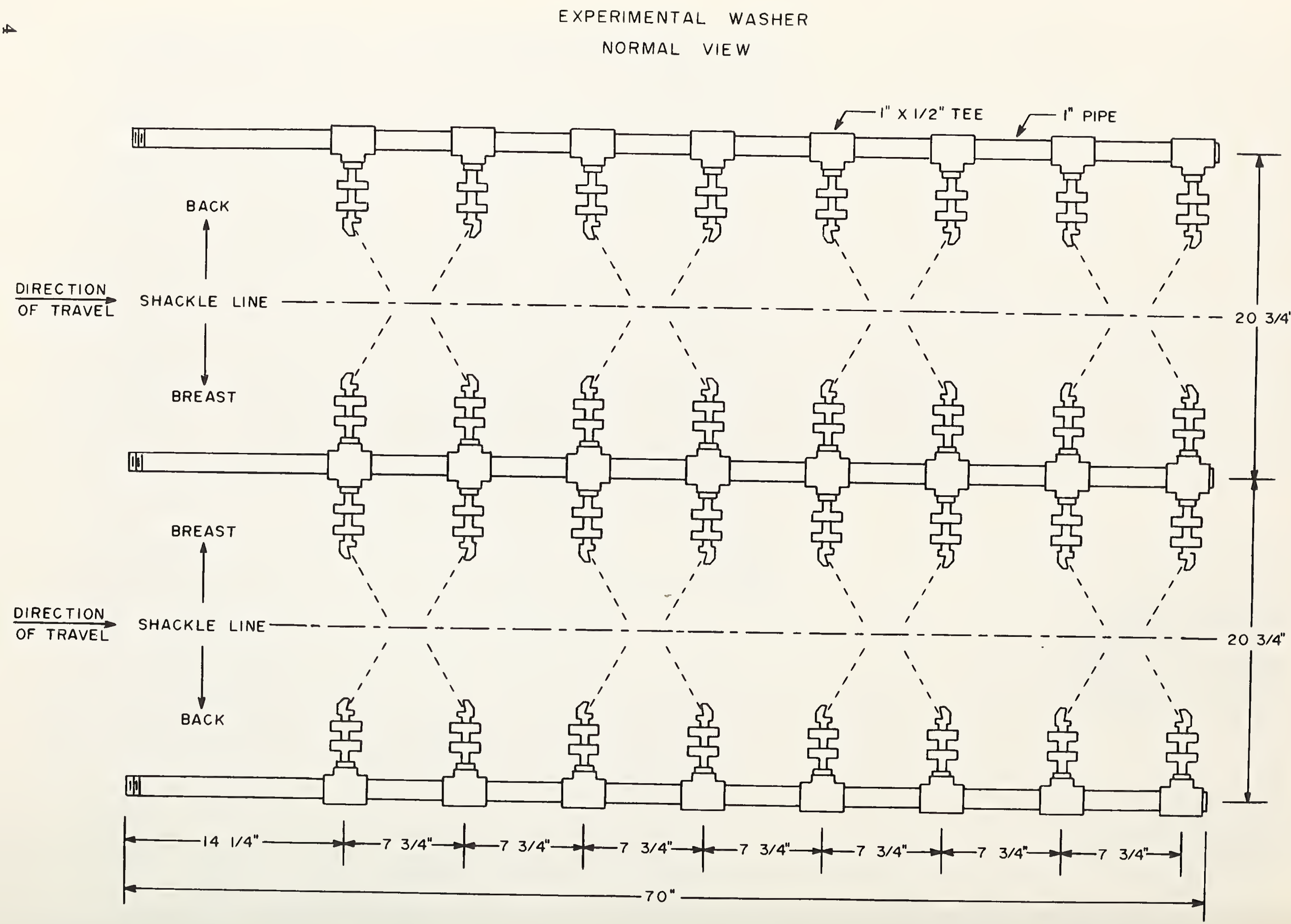


FIGURE 4.—Normal view of washer assembly for double eviscerating lines and spacing relative to shackle lines.

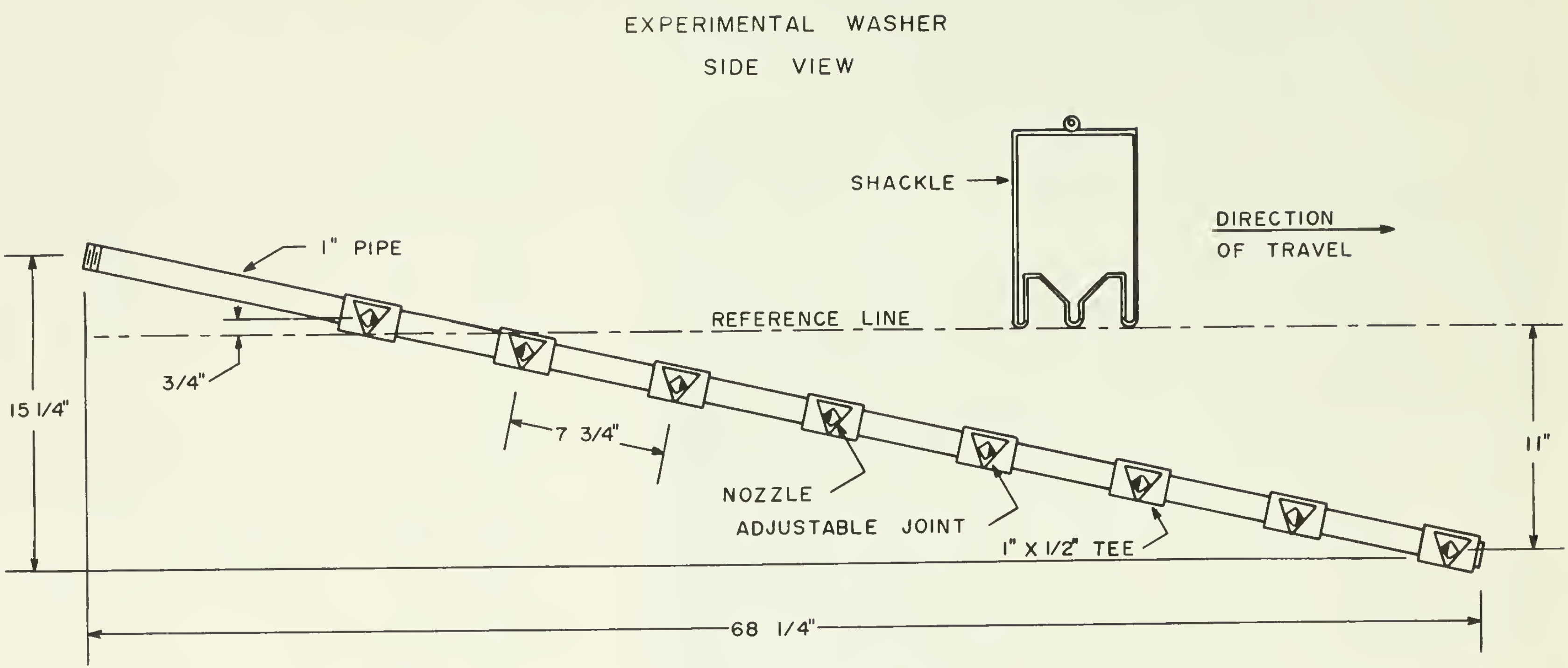


FIGURE 5.—Side view of washer assembly showing orientation of nozzles relative to bottom of shackle line.

FIGURE 6.—Experimental washer for double evisceration lines installed in an existing commercial processing plant washer tunnel.

a rack, allowed to drain for five minutes, and then reweighed. Birds passing through the experimental washer gained an average of 1.48 percent of their weight in water compared to 2.72 percent for those passing through the commercial washer.

## Microbiological Evaluation

A series of tests was made to determine the effects of nozzle size and water pressure on microbial counts. (This is not a criterion for accepting or rejecting the washer, since performance is rated on its ability to remove visible contamination from the carcasses.) Each of the two nozzles was investigated at water pressures of 10 and 20 lb/in$^2$ (four treatments per run). Water temperature for all treatments was adjusted as closely as possible to 58° F.

For each treatment, ten birds were removed from the eviscerating line in a commercial processing plant just before the final washer and taken to the laboratory. For determination of bacteria count, the birds were sampled on the left breast using the calcium alginate technique.[4] [5] The birds were then hung by the hocks on the shackles and passed through the washer (fig. 7). After washing, the carcasses drained for about 3 minutes and the swab sampling

[4] Fromm, D. An evaluation of techniques used to quantitatively determine the bacterial population on chicken carcasses. Poultry Science 38:887. 1959.

[5] Schuler, G. A., and Badenhop, A. F. Microbiological survey of selected poultry processing plants. From the proceedings of the 60th annual meeting of the Poultry Science Association. 1971.

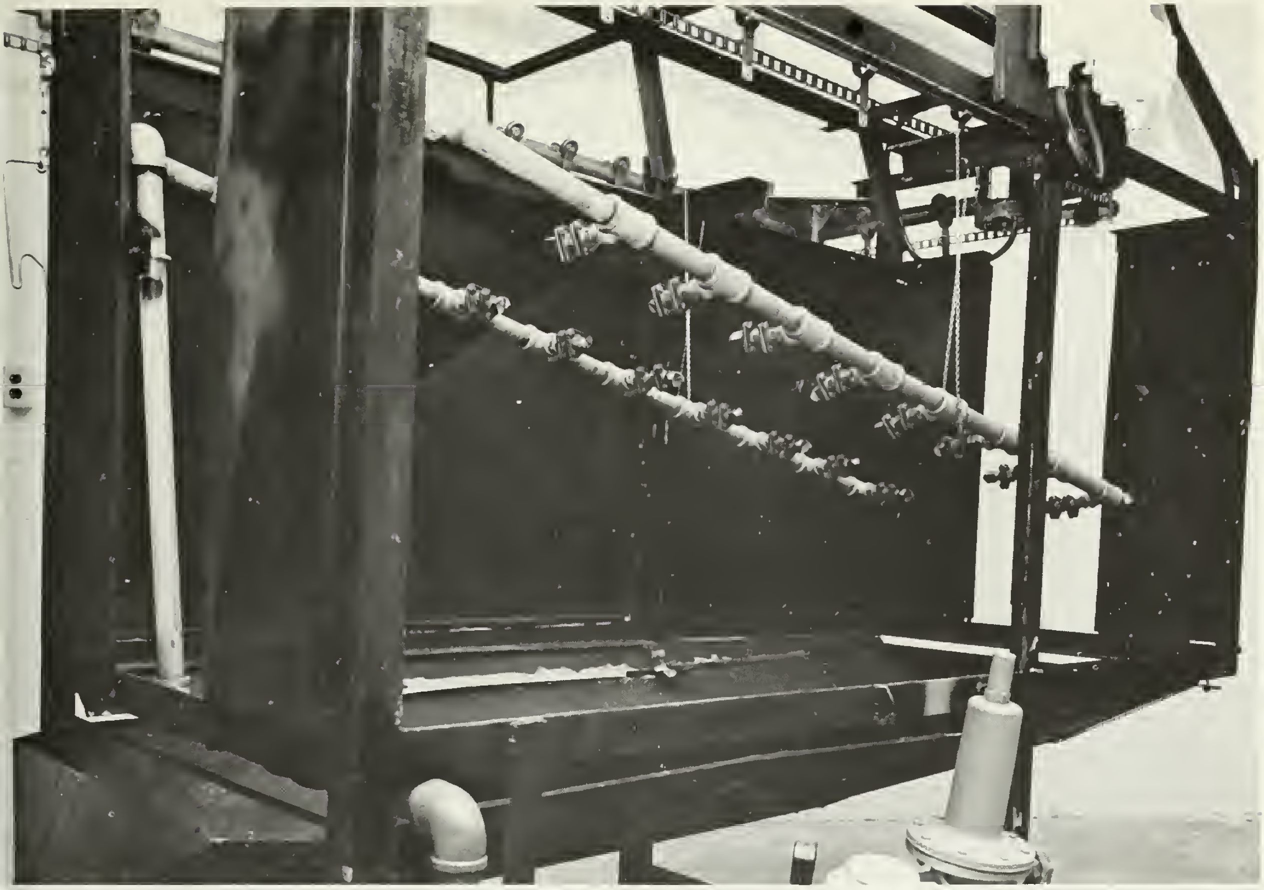

FIGURE 7.—Experimental washer manifolds and nozzle assemblies for single line of chickens installed in laboratory washer frame.

TABLE 1.—*Bacteria counts on breast skin of broiler carcasses before and after washing in experimental final washer*[1]

| Nozzle size and water pressure, lb/in² | Water flow rate, gal/bird | Water tempera-ture, °F | Bacteria per square centimeter, log | | |
|---|---|---|---|---|---|
| | | | Before wash | After wash | Reduction |
| 5/64-in. nozzle (No. 1/4 P5010). | | | | | |
| 10 | 0.18 | 60 | 3.39 | 3.29 | 0.10 |
| 20 | .26 | 58 | 3.39 | 3.11 | .28 |
| 1/8-in. nozzle (No. 3/8 P5025). | | | | | |
| 10 | .44 | 56 | 3.28 | 3.08 | .20 |
| 20 | .64 | 58 | 3.59 | 3.29 | .30 |

[1] Mean log of total organisms per square centimeter by swab method (10 birds in each of two replications).

procedure was then repeated on the right breast. The same procedure was followed on subsequent trials and the entire procedure was repeated.

The bacteria counts (table 1) are expressed as the mean logarithm of the actual counts. An analysis of variance of the reduction in bacteria showed no statistically significant differences among the various treatments. A tendency for the higher water pressure to be associated with a greater reduction in bacteria counts was detected, however.

At 20 lb/in$^2$ there was essentially no difference in bacteria reduction between the large and small nozzles. This is significant since the water output of the small nozzle was only about 40 percent that of the large nozzle output. The difference of 0.38 gallon per bird (0.64—0.26) in a washer handling 80 birds per minute would result in a water saving of 30.4 gal/min and a cash saving of about $875 per year for each washer.

## EQUIPMENT SPECIFICATIONS

Table 2 lists the components required to build or convert an existing washer to the more efficient cleaning system. An easily accessible on-off valve is essential since water must be shut off each time nozzle adjustments are made, and access to the nozzles is important for making the adjustments. Side doors similar to those shown in figure 6 provide this convenience. A filter in the supply line is required for uninterrupted operation of the spray nozzles, since without it debris and scale released into the lines can clog the small openings. The pressure regulating valve, costing less than $20, reduces line pressure to 20 lb/in$^2$ before water enters the washer, and can pay for itself many times each year by controlling water usage. A small booster pump should be used in-line ahead of the pressure regulator if there is danger that water pressure may drop below 20 lb/in$^2$. Low pressures render the washer ineffective. A pressure gauge is required on the washer side of the pressure regulator so that the water pressure going to the washer can be monitored at all times. The total cost of all components to provide an effective washing system for an eviscerating line is only $305.26.

The 5/64-inch nozzle (No. 1/4 P5010) is recommended, since it cleans as effectively as the 1/8-inch model (No. 3/8 P5025) with significantly smaller water consumption.

TABLE 2.—*Cost of components to build a flat-spray nozzle system for double evisceration lines*

| Item[1] | Number needed | Cost each | Cost total |
|---|---|---|---|
| Valve, gate, 1 in. | 1 | $ 2.90 | $ 2.90 |
| Filter, 1 in. | 1 | 17.85 | 17.85 |
| Booster pump, 1 hp. | 1 | 88.00 | 88.00 |
| Pressure regulator, 1 in. | 1 | 17.85 | 17.85 |
| Pressure gage, 0-30 lb/in$^2$ | 1 | 1.35 | 1.35 |
| Nozzles, flatjet (Spraying Systems Co. No. 1/4 P5010 and No. 3/8 P5025) | 32 | 1.84 | 58.88 |
| Adjustable joints, 3/8-in. or 3/8 × 1/4 in. | 32 | 1.55 | 49.60 |
| Reducers, 1/2 × 3/8 in. | 32 | .36 | 11.52 |
| Tees, 1 × 1/2 in. | 16 | 1.03 | 16.48 |
| Crosses, 1 × 1/2 in. | 8 | 1.57 | 12.56 |
| Nipples, 1 × 6 in. | 25 | .49 | 12.25 |
| Tees, 1 in. | 3 | .93 | 2.79 |
| Ells, 1 in. | 6 | .67 | 4.02 |
| Plugs, 1 in. | 3 | .27 | .81 |
| Pipe, 1 in. | (2) | (2) | 8.40 |
| Total | | | 305.26 |

[1] All pipe threads are NPT (National Pipe Thread) standard threads.

[2] 24 ft. needed. Cost, $0.35/ft.

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